NASA CASE NO. ARC-11,426-1

PRINT FIG. 1

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Filed: 8-26-83

(NASA-Case-ARC-11426-1) VISUAL ACCOMMODATION TRAINER-TESTER Patent Application (NASA) 20 p HC A02/MF A01 CSCL 14B

N84-12193

ARC

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THIS NASA INVENTION APPEARS TO HAVE EXCELLENT COMMERCIAL POTENTIAL

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SERIAL NO. 526,741
FILE DATE: August 26, 1983

NASA CASE NO. ARC-11426-1

VISUAL ACCOMMODATION TRAINER-TESTER

Invention Abstract

This invention relates to a device for training of the human visual accommodation system. Specifically, the device is useful for training a person to volitionally control his focus to his far point (normally infinity) from a position of myopia due to functional causes. The functional causes could be due, for example, to a behavioral accommodative spasm or the effects of an empty field. The device may also be used to measure accommodation, the accommodation resting position and the near and far points of vision.

The ophthalmic instrument (FIG. 1) includes a movable stage supported by a rail 18. Motion of the stage 20 to and from eyepiece 70 is produced by rotation of knob 22. The following elements are all aligned with optical axis 74: eyepiece 70, lens 64, lens 58, aperture 42, target 36, lens 32 and light source 30. Apertures 48 and 52 can be moved to the optical axis 74 by means of solenoids 44, 46 and switching circuit 78 (FIG. 2). Image 72 of target 36 is moved to and from the test subject when stage 20 is moved. The apertures are interchanged as necessary for the various measurement and training functions. The measurements are read out on diopter scale 23. In the training mode, for example, aperture 52 is employed and the subject strives to focus at his vision far point (normally infinity). When this occurs, only one image of target 36 is seen. Otherwise the subject visualizes two images, each one differently colored.

Never before has there been one single ophthalmic instrument that would perform all of the above-mentioned training and measurement functions. Previous training instruments lacked these measurement capabilities, were expensive and complex electro-mechanical devices, and were very difficult to master. In contradistinction, the subject invention is cost effective and very easy to operate. The components may be packaged in a very small volume. It is possible, for instance, to helmet-mount the device for human engineering investigations involving piloting aircraft, driving cars, operating computer terminals and so forth.

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EVALUATOR: Dr. Alan B. Chambers

United States Patent [19]

Randle

[11] **Patent Number:** **4,778,268**

[45] **Date of Patent:** **Oct. 18, 1988**

[54] VISUAL ACCOMMODATION TRAINER-TESTER

[75] Inventor: **Robert J. Randle**, Sunnyvale, Calif.

[73] Assignee: **The United States of America as represented by the Administrator of the National Aeronautics and Space Administration**, Washington, D.C.

[21] Appl. No.: **827,185**

[22] Filed: **Feb. 6, 1986**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 526,741, Aug. 26, 1983, abandoned.

[51] **Int. Cl.**[4] **A61B 3/00**

[52] **U.S. Cl.** **351/203**; 351/237

[58] **Field of Search** 351/200, 203, 237, 239, 351/243

[56] **References Cited**

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Randle, Volitional Control of Visual Accommodation, Conf. Proc. No. 82, Adaptation and Acclimatisation in Aero Space Medicine, Germany 9/1970.

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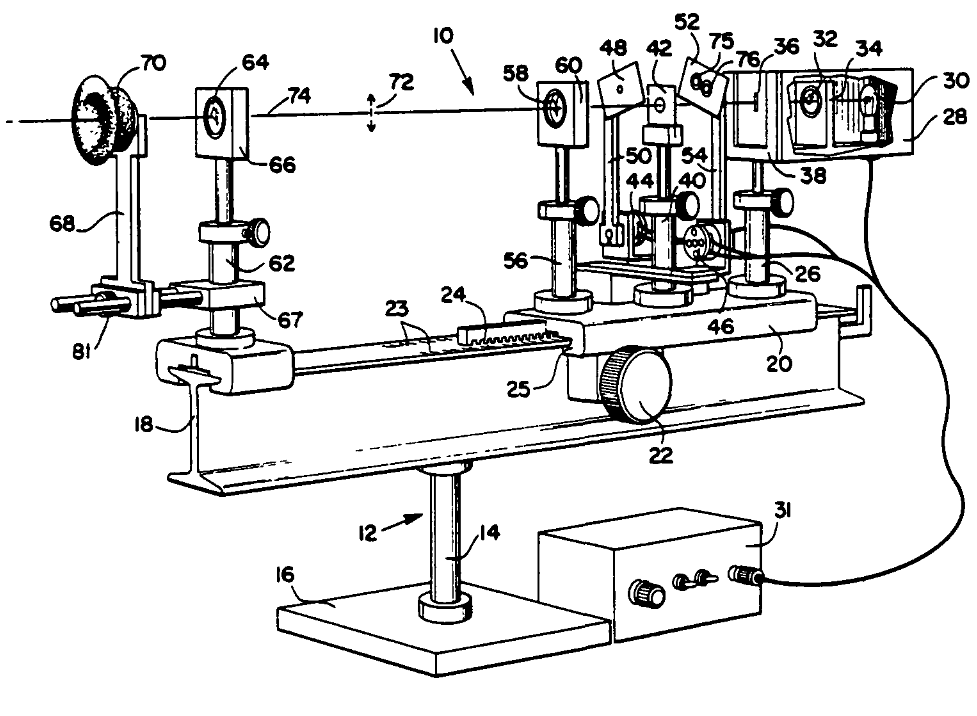
[57] **ABSTRACT**

The invention is an apparatus for training of the human visual accommodation system. Specifically, the apparatus is useful for training a person to volitionally control his focus to his far point (normally infinity) from a position of myopia due to functional causes. The functional causes could be due, for example, to a behavioral accommodative spasm or the effects of an empty field. The device may also be used to measure accommodation, the accommodation resting position and the near and far points of vision. The device comprises a number of optical elements arranged on a single optical axis (74). Several of the elements are arranged in order on a movable stage (20) in fixed relationship to each other: a light source (30), a lens (32), a target (36), an aperture (42), (48) or (52) and second lens (58). On base (18) and in fixed relationship to each other are eyepiece (70) and third lens (64). Stage (20) generates an image (72) of target (36) and the stage is movable with respect to base (18) by means of knob (22). The device is utilized for the various training and test functions by following a series of procedural steps, and interchanging the apertures as necessary for the selected procedure.

24 Claims, 2 Drawing Sheets



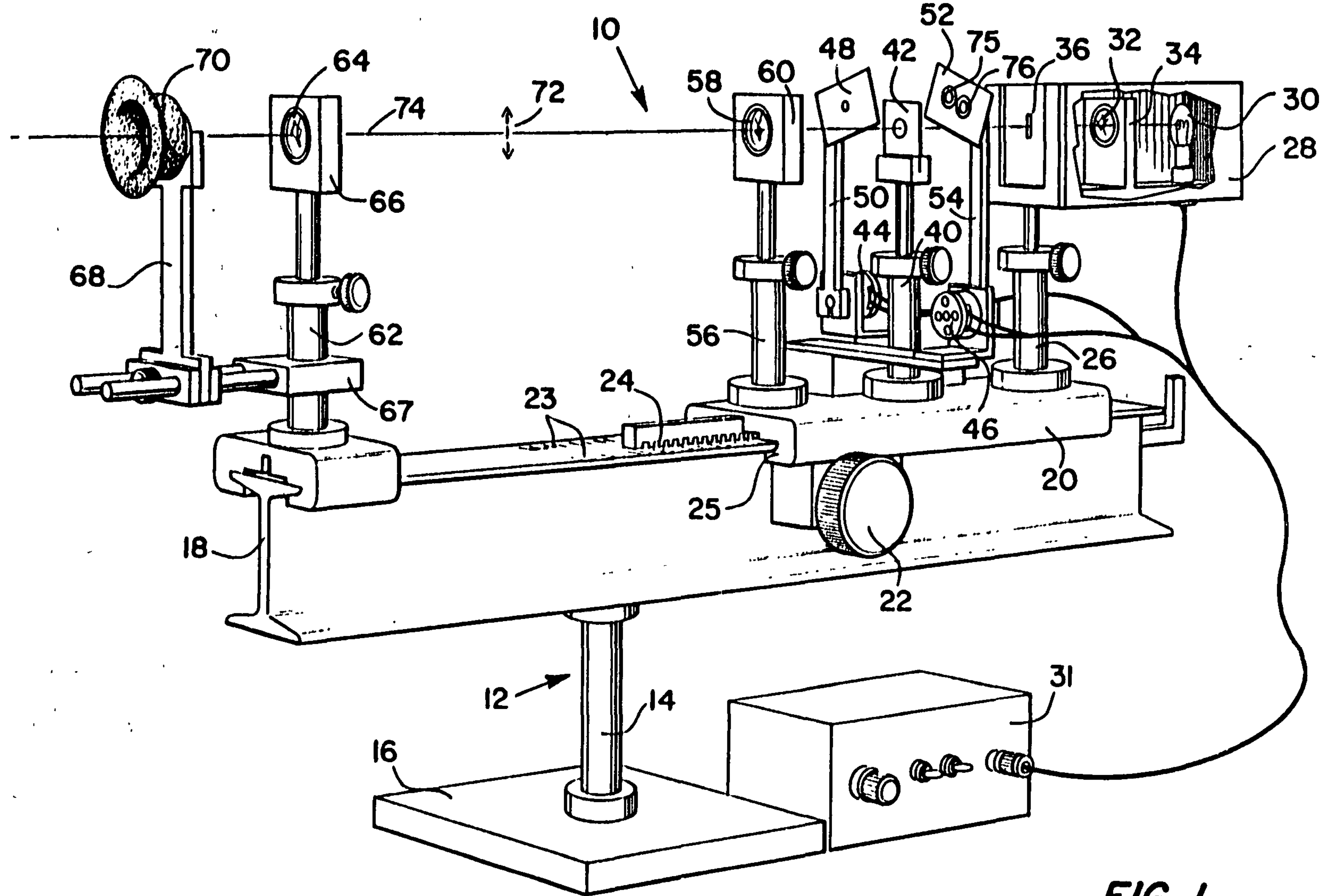

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FIG. 1

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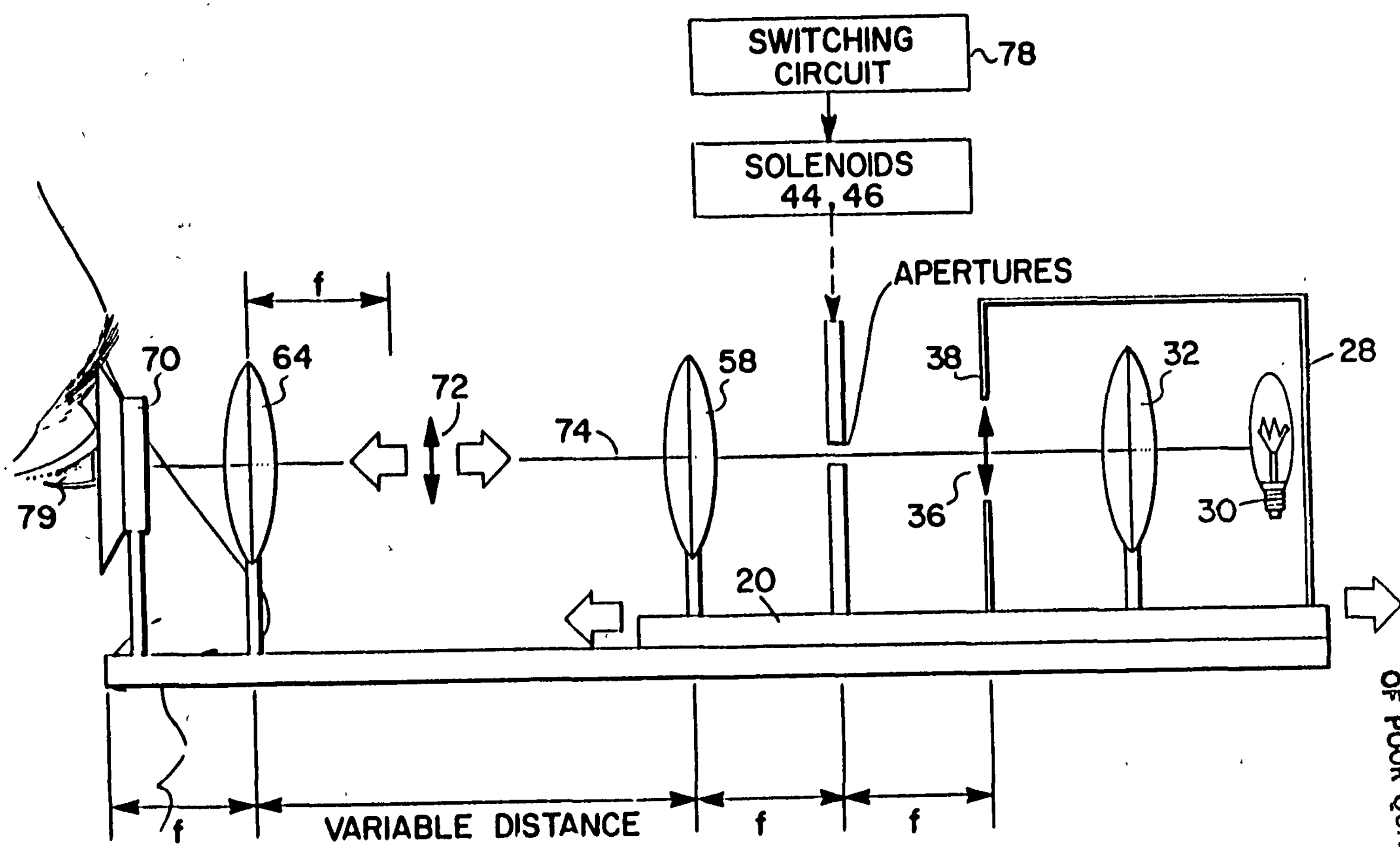

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FIG. 2

FILE DATE: August 26, 1983

NASA CASE NO. ARC-11426-1

VISUAL ACCOMMODATION TRAINER-TESTER

Origin of the Invention

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

Background of the Invention

1. Field of the Invention

This invention relates to a device for the training and measurement of the human visual accommodation system. Accommodation is the automatic adjustment of the eye for seeing at different distances and is effected by changes in the convexity of the crystalline lens. Specifically, the device is a training aid for teaching subjects to relax the eye muscles which are used to focus a sharp image on the retina of the eye and to instead focus at infinity. This is called relaxation of accommodation.

2. Description of the Prior Art

A normal, or emmetropic, eye will focus light rays from a distance on the retina by means of complementary deflections of the cornea, crystalline lens, and fluid of the eye. Light rays reflected from a distant object (beyond 25 feet) are considered to be parallel. With a nearer object, however, the reflected rays tend to diverge so that unless some correction is made, the rays will not focus on the retina. The correction is known as accommodation and is achieved through alteration of the anterior lens surface curvature by action of the ciliary muscle so that a retinal focus is

obtained. It is often necessary or desirable, for both medical and research purposes, to cause a person to relax his eye accommodation, that is to focus on a plane as far distant as possible, theoretically at infinity for a normal eye. Perhaps a most common instance when relaxation of accommodation is desirable is when an ophthalmologist examines a patient to determine whether or not he needs glasses. The ophthalmologist accomplishes this by using drugs to paralyze the eye muscles which control the eye lens or by changing a series of glass lenses in front of the patient's eye, using a technique called "fogging." Thus, one objective of an ophthalmologist is to prescribe glasses which allow the patient to see far-away objects clearly, provided his accommodation is fully relaxed. In order for the ophthalmologist to do this, the accommodation must first be fully relaxed before refraction measurements are taken. Accommodation relaxation can be important for a number of purposes other than just determining prescriptions for glasses as the inventor has discovered.

There are many situations where keen distant vision is very important. For example, it is necessary for all pilots to be able to perceive the existence of other aircraft in the airspace immediately ahead of their aircraft. Additionally, military pilots need to be able to detect other aircraft and identify them as friendly or hostile at the farthest distance possible. A need has developed for a device to train one to overcome empty field myopia and to provide therapy for behavioral myopia. Some past optometers employed such complex electro-mechanical systems that their operation was beyond nearly all people except the originators. For example, when the Cornsweet and Crane optometer, citation below, was turned over to a skilled Government scientist, it took the scientist over two months of

concentrated study and practice to even make the device work with modest success. If training human visual accommodation is ever to have wide application and become a real social benefit then a really practical, simple and inexpensive device must be provided. Accordingly, it is an object of the present invention to provide a device that is economical to fabricate, simple to operate, maintain, and transport that will: train the human visual accommodation system independently of other visuo-muscular systems; provide an accommodation stimulus and measurement tool in vision research; measure the accommodation resting position and the visual near and far points.

There is no known prior art device capable of performing all of these functions let alone one that is simple to operate and economical to construct. An exemplary prior art relaxer is disclosed in U.S. Patent No. 3,843,240 wherein a defocused flashing source of light is viewed through a pin-hole aperture to produce relaxation of the eye's accommodation powers. U.S. Patent No. 1,475,698 issued to Henker shows an apparatus for the objective measurement of the refractive value of the principal point of the eye. U.S. Patent No. 3,602,580 pertains to a method and apparatus for simultaneously refracting both eyes of a patient wherein a narrow beam of light is directed into each eye at a point spaced from the optical axis of the eye. An optometer of the Scheiner type is revealed in U.S. Patent No. 1,235,170 issued to Thorner. Expensive, servo-controlled optometers that are large, complex and difficult to use are mentioned in the following publications: Servo-Controlled Infrared Optometer, Cornsweet and Crane, Journal of the Optical Society of America, Vol. 60, No. 4, April 1970, pp. 548-554; Volitional Control of Visual Accommodation, R.J. Randle, AGARD Conference Proceedings No. 82 on

Adaptation and Acclimatisation in Aerospace Medicine, September 1970; and Accurate Three-Dimensional Eyetracker, Crane and Steele, Applied Optics, Vol. 17, March 1, 1978, pp. 691-705.

Summary of Invention

The present invention is an apparatus for training the human visual accommodation system, for measuring the accommodation, the accommodation resting position, and the visual near and far points. The training of the visual accommodation system is accomplished through a defocus feedback that is external to the natural, blurred-retinal-image feedback loop. The apparatus employs very few components and is very easy to use. The apparatus comprises a stationary base with a movable stage mounted on one end of the base. Five elements are mounted on the movable stage: a light source mounted at one end of the stage; a target mounted at the middle of the stage; a first lens mounted on the stage between the light source and the target; a second lens mounted at the opposite end of the stage; and a plurality of apertures are mounted on the stage between the second lens and the target. An eyepiece is mounted on the opposite end of the base; and a third lens is mounted on the base between the eyepiece and the second lens. The elements of the invention mounted on the movable stage are all in fixed relationship to each other and in movable relationship to the third lens and the eyepiece.

Brief Description of the Drawings

The invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a perspective view of the invention.

FIGURE 2 is a schematic diagram showing the elements of the invention and the location of the image of target 36.

Detailed Description of the Invention

Figure 1 shows a presently preferred embodiment of the invention for laboratory use, designated generally by the numeral 10. In the center of the figure is shown a stand 12 having a rod 14 extending upward vertically from a base 16. Attached to the top of stand 12 is a base plate or rail 18. Mounted on one end of base plate 18 is movable stage 20 which is driven by means of a rack 24 and pinion gear (not shown). Rotatable knob 22 is coupled to the pinion gear. Stage 20 may be moved toward or away from eyepiece 70 on base plate 18 by rotating knob 22 clockwise or counter-clockwise. A diopter and/or distance scale 23 is affixed to base 18 adjacent to rack 24 as for example by etching or painting. Scale 23 is read by using the edge 25 of stage 20 as a pointer.

A number of elements of the invention are all mounted on movable stage 20 in fixed relationship to each other. Vertically adjustable rod 26 affixed to stage 20 supports rectangular box 28 which contains a light source 30 and a first lens 32 mounted in holder 34. A target 36 is situated on end 38 of box 28. The target may transmit light therethrough from light source 30 with the area adjacent thereto being opaque or vice versa. End 38 of box 28 may be, for example, a photographic transparency with a desired image centrally positioned.

Mounted on vertically adjustable stand 40 adjacent to target 36 is a "wide open" aperture 42 about 8 mm in diameter. The aperture is positioned so that the optical axis 74 of lens 32 and the other lenses passes

centrally therethrough. Apertures 48 and 52 supported by pivotable arms 50 and 54, respectively may be moved onto the optical axis 74 by means of high speed solenoids 44 and 46, respectively. Aperture 48 is a "pinhole" aperture with an orifice of approximately 0.3 mm in diameter, whereas aperture 52 is a "Scheiner" aperture having two orifices about 0.5 mm in diameter, separated by 3.0 mm. When solenoid 46 is actuated, aperture 52 is moved to the position where the optical axis 74 bisects the two orifices. Apertures 42, 48 and 52 are not depicted to scale in Fig. 1. When the device is in use there is either one aperture on the optical axis (42) or two (42 and 48, or 42 and 52). As it is intended that aperture 42 be larger than aperture 48 or aperture 52, there is only one effective aperture on the optical axis at any given time (the smaller one). A switching circuit 78 (see Fig. 2) housed in cabinet 31 energizes solenoids 44 and 46. Specically, the switching circuit provides these selectable modes of operation:

1. The energization of solenoid 44 to move aperture 48 to the optical axis 74.

2. The energization of solenoid 46 to move aperture 52 to the optical axis 74.

3. The automatic alternate energization of the solenoids so that apertures 48 and 52 are alternately on optical axis 74. In this mode, it is preferable that the switching circuit include a user-selectable timing circuit so that the "on-axis" interval of aperture 52 may be varied.

Cabinet 31 also houses a power supply to provide power to lamp 30.

The orifices of Scheiner aperture 52 are covered with different colored filters 75 and 76, respectively. These filters may be, for example, red and green. These filters provide a cue for the direction of defocus when the image is split. On the proximal end of stage 20 is mounted a vertically adjustable stand 56 with second lens 58 and lens holder 60.

On the proximal end of rail 18 is a vertically adjustable stand 62 which supports lens holder 66 and third lens 64. Also attached to stand 62 is a bracket 67 supporting eyepiece 70.

Figure 2 shows the preferred spacing of certain items in the trainer-tester. Back-lighted target 36 is a fixed distance from second lens 58, twice the focal length (f) of lens 58. An image 72 of target 36 is formed the same distance on the other, left, side of lens 58. Of course as stage 20 is moved with respect to base 18 by means of knob 22, image 72 is moved with respect to stationary third lens 64. Eyepiece 70 is situated one focal length from third lens 64 and lamp 30 is spaced one focal length from first lens 32. The field of view of the target is determined by the size of the aperture 42, 48 or 52 and the distance of the target from the aperture. With the aperture diameters mentioned above and if lens 58 has a focal length of 10 centimeters, for example, there will be sufficient field of view available to stimulate a large portion of the retina of the viewing eye 79 and thus, a full accommodation response.

The several modes of operation of the apparatus will now be described.

<u>Measurement of the Far Point of Vision</u>

The vision far point (punctum remotum of accommodation) is defined in the Dictionary of Visual Science, Schapero, M., et al., Chilton Co., Phila., New York, 1960 as:

> The conjugate focus of the retina (fovea) when the accommodation is relaxed or at its minimum. In emmetropia, the far point is said to be at infinity; in myopia, it is at some finite distance in front of the eye; in hyperopia, it is at some finite (virtual) distance behind the eye.

What needs to be determined, therefore, is the optical distance from the subject's eye, at, and beyond which, the image of target 36 can no longer be kept in focus, i.e., when accommodation is fully relaxed. If the point at which the image can no longer be kept in focus is in front of the focal plane 80 of lens 64 the far point is closer than infinity and the eye is said to be myopic or "near-sighted." On the other hand, if the point is behind focal plane 80 (to the right of the plane in Fig. 2) the far point is said to hyperopic, (hypermetropic) or "far-sighted." If the point is right at the focal plane 80, the eye is then deemed emmetropic (normal).

For the measurement of the far point of vision the subject is preferably seated in front of device 10 with the entrance pupil plane of one eye placed at the eyepiece 70. The lamp 30 is illuminated and the wide-open aperture 42 is in place on optical axis 74. An image of target 36 is found at 72. This image is the object for lens 64 and the eye, and thus becomes the visual stimulus for the eye. The position of stage 20 is determined by the rotation of knob 22 which in turn determines the position of the subject's stimulus with respect to lens 64.

To start the measurement process the stimulus is initially placed by the examiner between lens 64 and focal plane 80. This requires the subject to exert some accommodative effort, an amount that is dependent upon where the stimulus has been placed with respect to lens 64. The scale 23 imprinted on base 18 and corresponding pointer (proximal end of stage 20) enables the measurement of the diopter value of power required at the eye to focus the stimulus (image 72). For convenience, scale 23 may also include a vision distance scale in addition to the dioptric scale to save the examiner the time needed to make the conversion from diopters to distance. The subject is requested to rotate the knob 22 to move the accommodation stimulus toward focal plane 80 and to stop the movement when the stimulus first appears to blur. When the blurring first occurs the point or scale 23 aligned with the pointer is read.

Because of the high variability in biological response systems, it is preferable to measure the far point by approaching it from both directions and then taking the average reading after several trials. That is, the subject moves the stimulus away from lens 64, from a position set by the examiner, until the stimulus blurs, the examiner reads the scale, the subject moves the stimulus, from a position selected by the examiner, towards lens 64 until the blurring of the stimulus stops, and the examiner reads the scale. This cycle is repeated for as many times as is deemed appropriate by the examiner and an average value of the dioptric distance is computed. This mean dioptric distance is the refractive error of the eye under test, and when converted to distance (through scale 23 or a simple calculation) is the monocular far point of vision of that eye.

Measurement of the Near Point of Vision

The Dictionary cited above defines the accommodative near point (punctum proximum) as:

> The point representing the maximum dioptric stimulus to which the eye can accommodate. Hence, usually the nearest point anteriorly on which the eye can focus.

The measurement process for determining the near point of vision is quite similar to the previous process. The measurement begins when the examiner, using knob 22, places the stimulus between lens 64 and focal plane 80. The subject then uses the knob 22 to move stage 20 and stimulus 72 toward him thus increasing the accommodative power required at the eye at eyepiece 70 to focus the stimulus. When the stimulus first starts to blur, the subject stops the movement of the stage 20 and the examiner notes where the pointer has stopped on scale 23. The bracketing procedure used above is also preferably employed here. In accordance with that procedure the examiner places the stimulus close to lens 64 such that it is too close to be focussed and will be observed as blurred. The subject then moves the stage 20 away from him until the stimulus first appears in focus. When the movement is stopped, the examiner reads scale 23. This blurring and clearing (approaching and receding stimulus) procedure is repeated as many times as is considered necessary by the examiner and a mean value of the several scale readings is calculated. This average value of accommodation, when converted to distance from diopters, is the monocular near point of vision of that eye.

It is well known that as a visual stimulus approaches the eye the pupil decreases in size as accommodation increases. The decreased pupil size causes increased depth of field and facilitates accommodation. This often results in a lazy or lagging response which does not necessarily indicate the true capability of the visual neuro-muscular system. To insure that the full accommodation range of the subject will be tested, the examiner may dilate the subject's eyes with a mydriatic. The mydriatic keeps the pupil large, deprives the eye of great depth-of-field, and fully taxes the accommodation capabilities.

Normally a defocused image is a blurred image. However, if an optical aperture having two laterally displaced orifices is placed in front of a lens, a single image of a point (or extended) source will be formed in a plane on the other side of the lens, conjugate to the object; all other planes are not conjugate to the object--they are defocused--so two images of the source will be formed. These images will be separated by a distance dependent upon the distance between the two small apertures and the distance of the images from the conjugate plane. Between the conjugate plane and the lens each image will lie on the same side of the optical axis as the aperture which formed it; on the side of the conjugate plane away from the lens each image will lie on the opposite side of the optical axis. Such a two-orifice aperture is known as a Scheiner aperture.

For measuring both the near point and the far point, the Scheiner aperture 52 may be used instead of, or alternately, with the wide open aperture 42. When aperture 52 is moved to the optical axis 74 by means of solenoid 46, the subject sees a single target image 72 only when it is in focus; the retina is conjugate to

72. For other situations, namely when image 72 is defocused, the eye at eyepiece 70 observes two displaced target images, each a different color (based on the colors of filters 75 and 76). The separation of the images is a function of the amount of defocus. It is easier for the subject to distinguish two displaced and different colored images than defocus blur of one image so greater accommodation measurement accuracy can be expected when aperture 52 is used for the near and far vision measurements.

Measurement of the Resting Position

When the eye has great depth-of-field, a position of tonic equilibrium occurs between the sympathetic and parasympathetic nervous systems and the eye is said to be at the resting position. The phenomenon, also called empty or dark field myopia, is an unconscious process and the resting position is almost never at infinity focus. Empirical studies indicate that normal eyes focus, on the average, about one meter in front of the eye. For a comprehensive study see, "The Dark Focus of Accommodation: Its Existence, Its Measurement, Its Effects," Nicholas M. Simonelli, AFOSR Technical Report Bel-79-3/AFOSR-79-7, prepared by the Behavioral Engineering Laboratory, New Mexico State University, November 1979.

Herein the eye is made to settle to its resting position by removing the defocus blur accommodation retinal stimulus. This is accomplished by placing pinhole aperture 48 on optical axis 74 by means of solenoid 44. The aperture increases the depth-of-field so much that no stimulus blur is apparent to the eye under test.

In accordance with this measurement, lamp 30 is illuminated, aperture 48 is initially placed on optical axis 74, the subject's eye to be tested is placed at eyepiece 70, and the subject's other eye is occluded or covered. Stage 20 is moved so that stimulus 72 is positioned at the subject's previously measured far point and the subject is allowed a reasonable time for accommodation to settle (more than one minute). After sufficient time has been allowed for settling, solenoid 44 is de-energized moving aperture 48 off of the optical axis and aperture 52 is moved thereon by solenoid 46. After an interval shorter than the accommodation latency period, about 250 milliseconds, aperture 52 is removed from optical axis and aperture 48 is returned to it. During the brief period that aperture 52 is on the optical axis, the eye under measurement will observe two displaced images, each differently colored, if the eye has drifted to its resting position. This is an easy pattern to discern even during the brief period that aperture 52 is on the optical axis.

At regular intervals aperture 52 is brought back to the optical axis for a brief period while aperture 48 is moved to its off-axis position. As the alternation occurs, the subject is directed to move stage 20 in a direction that will cause the two colored images to be superimposed. The correct direction to move the stage will be immediately apparent to the subject because of the orientation of the two colored images. When the images are superimposed and the stage is brought to rest, the pointer for scale 23 indicates the empty field myopia, that is, the resting position of the eye.

Training Visual Accommodation

The subject invention has three salient visual accommodation training features: (1) It can open the accommodation loop (nullify defocus blur) to allow volitional control to be brought into play; (2) It can provide a defocus cue (feedback) that is not normally available in real world visual tasks; and (3) It allows accommodation to be decoupled from binocular vergence by using only one eye, thus limiting it to a more pure accommodation response. Inasmuch as willed control is initiated and completed in higher neural centers than at each individual eye, both eyes benefit when only one eye is trained.

The subject invention is so versatile that it permits many strategies for training the volitional control of accommodation. Hereinafter is but one training strategy, that of volitionally controlling one's focus to one's far point (normally infinity) from a position of myopia due to functional causes. The functional causes could be due, for example, to a behavioral accommodative spasm or the effects of an empty field. Other strategies will be apparent to a skilled clinician.

To implement the training, the device 10 is operated as it is for the measurement of the resting position and the subject's eye not in the eyepiece is either occluded or covered. As aperture 52 is periodically and briefly positioned on optical axis 74 (alternately with aperture 48), the subject is instructed to not touch knob 22, but to exert volitional control on the eye so as to fuse together the two different colored images. After some practice, trainees can learn how to drive their accommodation in the appropriate direction to achieve the superimposition of images. It is not known how this is accomplished nor have users of the device been able to explain how they fuse the images.

Some trainees have been able to achieve the task with as little as one hour of training. After some practice and reinforcement a trainee is weaned from the device and can utilize the new accommodation skill in the real world. To enhance the training and make it possible for the trainee to alternately view real world objects and stimulus 72 without leaving eyepiece 70, a 50/50 beamsplitter may be added to the apparatus. When the beamsplitter is added, the eyepiece is rotated 90 degrees so that its viewing axis is orthogonal to optical axis 74. The beamsplitter is placed where the two axes cross. Thus, the subject may either look through the beamsplitter at the real world or look on the beamsplitter for stimulus 72. When operated thusly, neither eye is occluded, binocular viewing is in force, and binocular accommodation is measured.

The components of the instrument need not be supported on tall stands or on a base as large as 18. The instrument may be repackaged in a much smaller volume. It is possible, for instance, to helmet-mount the device for dynamic studies in piloting aircraft, driving cars, operating computer terminals, and other human engineering investigations without intervention in the on-going visual task.

The advantage of this invention over present day devices is that it brings together multiple accommodation measurement/training features in one instrument that is easy to operate and economical to construct. This invention combines in one ophthalmic instrument a device for: (a) training the human visual accommodation system independently of other visuo-muscular systems; (b) measuring the visual near and far points; (c) measuring the accommodation resting position; and (d) use as an accommodation stimulus and measurement device in vision research.

VISUAL ACCOMMODATION TRAINER-TESTER

Invention Abstract

The invention is an apparatus for training of the human visual accommodation system. Specifically, the apparatus is useful for training a person to volitionally control his focus to his far point (normally infinity) from a position of myopia due to functional causes. The functional causes could be due, for example, to a behavioral accommodative spasm or the effects of an empty field. The device may also be used to measure accommodation, the accommodation resting position and the near and far points of vision. The device comprises a number of optical elements arranged on a single optical axis (74). Several of the elements are arranged in order on a movable stage (20) in fixed relationship to each other: a light source 30, a lens (32), a target (36), an aperture (42), (48) or (52) and second lens (58). On base (18) and in fixed relationship to each other are eyepiece (70) and third lens (64). Stage (20) generates an image (72) of target (36) and the stage is movable with respect to base (18) by means of knob 22. The device is utilized for the various training and test functions by following a series of procedural steps, and interchanging the apertures as necessary for the selected procedure.

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